

Site Need Statement

General Reference Information	
1 *	Need Title: Double Shell Tanks (DST) Corrosion Chemistry
2 *	Need Code: RL-WT079-S
3 *	<p>Need Summary: Tank waste chemistries and temperatures within the DST operating limits for corrosion control and operating temperature range may not provide the expected corrosion protection, necessitating the need to evaluate future operations for the conditions outside the existing corrosion database. Such studies will help in assuring the availability of the DSTs to support future waste retrieval missions. Future tank waste operations are expected to process wastes that are more dilute with respect to some of the corrosion inhibiting waste constituents. Therefore, this need calls for the implementation of an effort to evaluate three aspects of the chemistry control program, by understanding the nitrite and hydroxide depletion reactions, by developing empirical equations from depletion reaction models, and lastly, through laboratory testing provide recommendations to enhance the corrosion control limits. This two-year investigative and laboratory corrosion testing effort will encompass additional time needed to assemble analytical and empirical information, design the test program, and complete data analysis and final reporting. The tests will be conducted on simulated (non-radioactive) wastes with chemistries bounding the variations of chemistry in current DSTs and bridging to dilute waste chemistries expected in the future at temperatures covering the current and future DST operating ranges. Analytical and tank waste sampling data will be evaluated to determine probable chemistry reactions and behavior models.</p> <p>The waste in double-shell tank (DST) 241-AN-107 had been outside corrosion chemistry control limits for several years. However, limited UT examination performed in 1998 indicated the tank to be corroding at a very low rate with no observable pitting or stress corrosion cracking (SCC). The UT results were supported by the more recent examination of corrosion probe coupons removed from tank 241-AN-107 after approximately 4 years of exposure to tank waste. The coupon analysis indicated very little general corrosion in tank waste with no observable pitting and SCC. This suggests that the current DST waste chemistry limits may be conservative. Several tanks currently contain sludges with interstitial liquids that fall outside the chemistry control limits and with limited means available for adjusting the waste composition. Recent sample results from tank 241-AY-102 identified that sludge interstitial liquid nitrite composition had been depleted. This nitrite depletion is speculated to be the result of organic reactions with the nitrite. Empirical equations representing the organic hydroxide depletion reaction have been developed as well as empirical assessment of organic nitrite waste characterization. Further understanding as to the cause of such reactions is needed to enhance the chemistry control program. Previous studies by Pacific Northwest National Laboratory have identified dilute waste chemistries promoting excessive corrosion attack, and more concentrated wastes producing high corrosion rates at temperatures above the normal DST operating temperature range. The investigative and laboratory studies will address the two types of steel (A515/516, A537) used in the construction of the DSTs, the past thermal and operational history of the tanks, and future projected uses.</p> <p>This corrosion control issue will affect all of the dilute waste storage tanks at Hanford, and may ultimately impact all 28 DSTs.</p>
4 *	Origination Date: FY 2000
5 *	Need Type: Science Need
6	Operation Office: Office of River Protection (ORP)
7	Geographic Site Name: Hanford Site
8 *	Project: Safe Storage/Tank Farm Operations PBS No: RL-TW03
9	<p>National Priority:</p> <p><u>X</u> 1. <u>High</u> - Critical to the success of the EM program, and a solution is required to achieve the current planned cost and schedule.</p> <p>2. Medium - Provides substantial benefit to EM program projects (e.g., moderate to high life-cycle</p>

	cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays).
	___3. Low - Provides opportunities for significant, but lower cost savings or risk reduction, may reduce the uncertainty in EM program project success.
10	Operations Office Priority: High
Problem Description Information	
11	<p>Operations Office Program Description: The overall purpose of the safe-storage function is to operate and maintain the double shell tank (DST) and single shell tank (SST) farms in a safe and compliant manner until the contained wastes are retrieved and the tank farms are ready for closure. This includes performing day-to-day operations, maintaining and upgrading infrastructure, resolving safety issues, assessing tank integrity, characterizing the waste, and managing the DST waste inventory. This function also includes interim stabilization of selected SSTs. The end state of safe storage is containment of DST and SST tank wastes in a manner that supports safe waste retrieval for final waste disposal; tank-farm structures, including DSTs and SSTs, ready for final disposal and closure; and tank farms amenable and ready for the mitigation of any environmental releases that occurred during storage and retrieval of tank waste.</p>
12	<p>Need/Problem Description: Corrosion control of DSTs is accomplished by operating the tanks within the corrosion chemistry control limits. Monitoring the chemistry of tank waste is performed using process knowledge and tank sampling. Tanks found to be within chemistry specification limits are considered to be not at risk for excessive corrosion damage. However, four DSTs are currently operating with low hydroxide (out of corrosion specification) concentration and one of these tanks is also operating with low nitrite concentration. Tank samples are taken at a minimum frequency of every 5 years and their analysis is difficult and expensive. Process knowledge is complicated because of waste streams (notably line flushes and process condensate recycle) that are exempt from the corrosion control specifications. The laboratory database for the corrosion control chemistry specifications is 20 years old and was formulated on waste chemistries no longer produced at Hanford. As tank waste chemistries change over time, they drift to the fringes of the acceptable envelope for corrosion control. There is increasing evidence that these new waste chemistries (including those of the future waste operations) have corrosion characteristics that cannot be reliably predicted from the models developed by the old laboratory studies. New laboratory studies need to be conducted to better characterize the conditions of the future waste tank operations and the changing waste chemistry conditions of the present tank wastes.</p> <p>Chemical changes occur in the waste over time to deplete corrosion inhibiting chemicals (hydroxide and nitrite). An understanding of these depletion reactions is needed to develop empirical equations and depletion models that can be used to predict the changing chemistry of DST wastes. These equations and models will serve as tools to ensure timely corrective actions will be taken to keep the tank wastes within the corrosion control chemistry limits. Maintaining the DST waste chemistries in compliance with corrosion control limits reduces the risk of tank failure and helps to ensure availability of tanks for future retrieval and waste treatment operation.</p> <p> ** Program Baseline Summary (PBS) No.: RL-TW03 ** Work Breakdown Structure (WBS) No.: 5.01.03.05 ** TIP No.: T03-01-100 </p> <p>Consequences of Not Filling Need:</p> <p><u>Regulatory Impacts</u> Waste compatibility is one area that must be addressed in tank system integrity assessments, per Washington Administrative Code (WAC) Dangerous Waste Regulations (WAC 173-303-640).</p> <p><u>Programmatic Impacts</u> Corrosion control of DSTs is accomplished by operating the tanks within the corrosion chemistry control limits. Monitoring the chemistry of tank waste is performed using process knowledge and tank sampling. The finding of no significant wall thinning in a limited ultrasonic examination of 241-AN-107 coupled with negligible corrosion observed in corrosion probe coupons exposed in 241-AN-107 waste, which is</p>

	not in compliance with current waste chemistry limits, suggest that corrosivity of wastes in Hanford's waste storage tanks may not be sufficiently well understood and the present corrosion chemistry control limits may be conservative. There are several tanks (with limited capability for making adjustments) that contain sludges outside the chemistry control limits and the corrosion behavior of these sludges is unknown. Tank samples are taken at an established frequency and their analysis is difficult and expensive. Process knowledge is complicated because of waste streams that are exempt from the corrosion chemistry control limits.
13	<p>Functional Performance Requirements: The proposed laboratory study will establish the waste composition limits for the DSTs to control corrosion process at acceptable levels during the future waste retrieval and treatment missions at the Hanford Site. Excessive corrosion will specifically be defined as:</p> <ul style="list-style-type: none"> • Any evidence of stress corrosion cracking. • Any evidence of the onset of pitting. • Uniform corrosion rates of greater than 1 mil per year. <p>Privatization Potential: There is limited privatization potential for the results of this laboratory corrosion study.</p>
**	Schedule Requirements: Work is to be initiated in fiscal year 2002 and completed by fiscal year 2004.
14	Definition of Solution:
15 *	Targeted Focus Area: Tanks Focus Area (TFA)
16	Potential Benefits: Extended tank life, delayed cost of new tanks.
17	Potential Cost Savings: See narrative below.
18	<p>Potential Cost Savings Narrative: The existing Technical Safety Requirement (TSR) for DSTs prescribes waste chemistry requirements for the purpose of limiting corrosivity, and prolonging tank life. The DSTs will be needed well beyond their design life to support the future waste retrieval and treatment missions at the Hanford Site. Construction of new waste storage tanks could be required if remaining tank life is projected to fall short of the projected River Protection Project (RPP) mission duration. The estimated cost to build a new 6-tank farm (Multi-Function Waste Tank Facility) was \$435 million in 1993 dollars. It is difficult to quantify the benefit (in dollars) of gaining an improved understanding of DST corrosion chemistry. However, it is clear that decisions on corrosion inhibitor addition and DST replacement, which necessarily require an understanding of the effects of waste chemistry on tank corrosion, have the potential to significantly impact RPP life cycle costs in the range of 100s of millions of dollars. Improved understanding of the effect of DST waste chemistry on tank corrosion would improve the underlying justification for those decisions.</p>
19	Cultural/Stakeholder Basis: Given the history of single-shell tank failures and resulting contamination of soil and groundwater, uncertainty regarding effects of DST waste chemistry on corrosion and potential DST failure could raise stakeholder concerns.
**	<p>Technical Basis: The laboratory database for the corrosion control chemistry specifications is 20 years old and was formulated on waste chemistries no longer produced at Hanford. As tank waste chemistries change over time, they drift to the fringes of the acceptable envelope for corrosion control. There is increasing evidence that these new waste chemistries (including those of the future waste operations) have corrosion characteristics that cannot be reliably predicted from the models developed by the old laboratory studies. New laboratory studies need to be conducted to better characterize the conditions of the future waste tank operations and the changing waste chemistry conditions of the present tank wastes.</p> <p>DOE Order 5820.2A, <i>Radioactive Waste Management</i>, requires monitoring of cathodic protection systems, methods for periodically assessing waste storage system integrity, and adjustment of waste chemistry to control corrosion.</p> <p>DOE-STD-1073-93, <i>Configuration Management</i>, requires implementation of a Material Condition and Aging Management Program to control aging processes in major equipment and components. The primary aging processes in waste tank systems are corrosion related.</p>

	DOE/RL-92-60, <i>Tank Waste Remediation System Functions and Requirements</i> contains corrosion control requirements for the Store Waste (F4.2.1.1) and Transfer Waste (F4.2.4.4) functions.
20	<p>Environment, Safety, and Health Basis: HNF-SD-WM-TSR-006, <i>Tank Farms Technical Safety Requirements</i>, Administrative Control 5.15, <i>Chemistry Control Programs</i>. This document contains operational safety requirements – administrative controls for corrosion control, cathodic protection, and integrity assessments. Implementation of these administrative controls necessitates corrosion control activities.</p> <p>RPP-8173, Rev. 1, <i>Technical Basis for Caustic Additions to tanks 241-AN-102, 241-AY-101, 241-AY-102, and 241-AN-107 – Draft</i>, discusses the principal corrosion mechanisms (uniform corrosions, pitting, and stress corrosion cracking) that play an active role in DST primary wall corrosion and provides estimates of remaining useful lives for these tanks.</p> <p>RPP-7795, Rev. 1, <i>Technical basis for chemistry control Program</i>. This document discusses current waste composition and sampling requirements to maintain the waste chemistry within specification, depletion mechanisms, and empirical equations used to estimate the rate of depletion of free hydroxide in the tank waste.</p> <p>BNL/DOE-HQ Tank Structural Integrity Panel, <i>Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks - DRAFT</i>, discusses the important role of corrosion monitoring in the context of a comprehensive structural integrity program.</p>
21	<p>Regulatory Drivers: <i>Washington Administrative Code</i> 173-303-640(2)(c)(iii) requires consideration of existing corrosion protection when performing tank system integrity assessments.</p> <p>HNF-SD-WM-OCD-015, <i>Tank Farm Waste Transfer Compatibility Program</i>, describes decision rules relating to waste transfers into and within the DST system. The document defines a means of consistently applying safety, operational regulatory and programmatic criteria and specifies considerations necessary to assess waste transfers.</p> <p>BNL/DOE-HQ Tank Structural Integrity Panel, <i>Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks - DRAFT</i>, discusses the important role of corrosion monitoring in the context of a comprehensive structural integrity program.</p>
22	Milestones: N/A
23	Material Streams: Tanks and Residuals, HLW-HANF-3 (Double Shell Tanks); sludge, salt, liquid (RL-HLW-20)
24	TSD System: Double Shell Tanks
25	Major Contaminants: Pu-238, 239, 240, 241; AM-241; U-238; C-14; Ni-59/63; Nb-94; Tc-99; I-129; Cm-242; Sr-90; Cs-137; Sn-126; Se-79; chromium; nitrate; nitrite; complexants (EDTA/HEDTA)
26	Contaminated Media: N/A
27	Volume/Size of Contaminated Media: All double shell tanks are 75 feet in diameter, and about 40 feet deep, with their tops buried about 10 feet below the ground surface.
28*	Earliest Date Required: 1/1/2001
29 *	Latest Date Required: 10/1/2004
Baseline Technology Information	
30	Baseline Technology/Process: Corrosion control of DSTs is accomplished by operating the tanks within the corrosion chemistry control limits. Monitoring the chemistry of tank waste is performed using process knowledge and tank sampling. Sample results for hydroxide, nitrite and nitrate concentrations are compared to established operational limits. A tank is currently considered to be not at risk for excessive

	corrosion if the chemistry is within the specified limits. Technology Insertion Point: T03-01-100
31	<i>Life-Cycle Cost Using Baseline:</i> \$1,850K
32	<i>Uncertainty on Baseline Life-Cycle Cost:</i> -50% to +100%
33	<i>Completion Date Using Baseline:</i> 10/1/2004
Points of Contact (POC)	
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*Element of a Site Need Statement appearing in IPABS-IS